

SECTION 15600
HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A.** Work Included: This Section specifies HVAC systems. Applicable requirements of Section 15050 - BASIC MATERIALS AND METHODS FOR MECHANICAL WORK apply to the Work of this Section.
- B.** Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 07840 - FIRESTOPPING.
 - 2. Section 15050 - BASIC MATERIALS AND METHODS FOR MECHANICAL WORK.
 - 3. Section 15800 - AIR DISTRIBUTION.
 - 4. Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.
 - 5. Section 16920 - MOTOR CONTROL CENTERS AND MOTOR STARTERS.

1.2 SUBMITTALS

- A.** Working Plans and Certificates
- B.** Shop Drawings
- C.** Operation and Maintenance manuals

1.3 DELIVERY, STORAGE, AND HANDLING

- A.** Protection
 - 6. Protect work, equipment and materials from dirt, water, chemical, or mechanical damage.

1.4 QUALITY ASSURANCE

- A.** Requirements of Regulatory Agencies

PART 2 - PRODUCTS

2.1 PIPING

- A.** Pipe and Fittings: As specified in Section 15050 - BASIC MATERIALS AND METHODS FOR MECHANICAL WORK and complying with the following requirements:

Service	Class
1. Fuel Oil a. Underground Supply, Return and Interior: b. Fill and Vent:	K T
2. Hot Water Heating	T
3. Steam, Low and Medium Pressure.(5 to 15 and 30 to 50 psi respectfully): a. Supply: b. Return:	T S
4. Chilled Water:	T
5. Refrigeration:	K

2.2 FUEL OIL SYSTEMS

- A.** General:

1. Provide tanks having capacity as indicated, complete with standard tappings unless otherwise indicated; supply and return piping, including locking type fillbox and weather hood vent cap, pumps, control systems, hold-down anchors, gauge stick, calibration chart and other appurtenances as required for complete systems. Additionally, provide wall mounted remote tank liquid level gauges manually operated, hand pump, hydrostatic type capable of being located up to 150 feet from tanks. Sizes and types of gauges in relationship to tank height and capacity as specified in the Construction Specifications. Provide complete with necessary tubing in minimum two-inch galvanized conduit between tanks and remote gauge as indicated.
2. Provide tanks complying with NFPA 31 and State Board of Fire Prevention Regulations 527 CMR 9.00.
3. Furnish materials and equipment complying with following:
 - a. Bearing evidence of UL listing where UL standards exist and such product listing is available.
 - b. Bearing evidence of approval by Commonwealth of Massachusetts, where applicable.

- B.** Steel Tanks: Provide tanks complying with STI-P3 complete with electrical isolation and cathodic protection.

C. Fiberglass Tanks

1. Provide fiberglass reinforced polyester type complete with lifting lugs capable of withstanding weight of tank with minimum safety factor of three and fiberglass-reinforced plastic anchor straps.
2. Provide each tank with fiberglass-reinforced plastic fill tube minimum four inches in diameter unless otherwise indicated.

D. Interior Tanks: Provide tanks complying with previous paragraphs; and having minimum capacity of 275 gallons, except day tanks, unless otherwise indicated; with standard low opening, top gauge connection, fill and vent openings, pipe leg mounting stand, and top gauge with 0, 1/4, 1/2, 3/4 and full readings.

2.3 UNIT HEATERS

A. General

1. Provide heaters having capacities, air delivery, pressure drop, maximum final temperature and motor speed as indicated, rated in accordance with ASHRAE (Test Code 2) and having minimum BTU capacity not in excess of 125% of that indicated.
2. Provide heaters from same manufacturer in order to simplify maintenance equipment and procedures.

B. Types

1. Type A - Unit Heaters: Provide suspended propeller type, arrange for horizontal or vertical discharge of air, 115 volt single phase as indicated, with air deflectors for diffusing and distributing air, manual switch and thermal overload device.
2. Type B - Self-Contained Cabinet Type: Provide centrifugal fan cabinet type with multi-speed fan control and built-in thermostatic control, complete with insulation, filters and removable grill panels.

C. Room Thermostats for Hot Water or Steam Unit Heaters

1. General: Provide explosion-proof, auto-on sub-base, line-voltage, two-wire, heavy-duty type with range of 56 to 84°F and indicating thermometer.
2. Hot-Water Unit Heaters: Provide heaters with two or three pole, 120 volt, relay to control circulator, as indicated.

2.4 EQUIPMENT

A. Electric Duct Heaters

1. Type: Coil, resistor, designed to slide into the ducts.

2. Rated 1.5 KW and Lower: Suitable for operation on 110V, 60 hertz, single-phase.
3. Rated Above 1.5 KW: Circuited in equal stages, each not to exceed 1.5 KW, and suitable for operating on 208V, 60 hertz, single-phase.
4. Standard: UL Label.
5. Heating Elements: Nickel chrome fan mounted with finned tube elements centered within the tubes and embedded in compacted insulating material with flanges and fins permanently furnace-brazed to the elements, each element and fin continuously coated with a heavy layer of ceramic material, fired at not less than 1500°F.

2.5 RADIATORS

- A. Radiators: Extended surface-finned tube radiators consisting of suitable 4-1/4 inch square steel fins bonded to 1-1/4 inch steel tube, 33 fins per foot. Provide radiators of capacities not less than those indicated, determined in accordance with I-B-R Code, and equipped with solid front, slotting slopping top covers, fabricated from steel sheets not less than 18 USS gauge, independently secured to building walls with suitable brackets. Run radiator covers as indicated with corner fittings and end covers as necessary. Provide each hot water radiator with an automatic air vent enclosed in a special access panel with hinged cover. Apply a coat of rust-inhibiting paint to radiators before shipment. Equip the hot water supply pipe to each radiator with a radiator valve, packless hot water type. Equip the return pipe from each radiator with a balancing fitting. Provide enclosure with baked enamel finish of color selected by the Engineer. Provide access to valves through hinged access doors.
- B. Equip steam radiators with radiator valve on supply pipe to each radiator and thermostatic steam trap on return line, as indicated.

2.6 BASEBOARD RADIATORS

- A. Extended surface-finned tube radiators of suitable 2-3/4 inch by 5 inch, 0.016 aluminum fins bonded to 1-1/4 inch nominal copper tube of 48 fins per foot. Provide radiators of capacities not less than those indicated, determined in accordance with I-B-R code, and equipped with snap-on cover, position damper control, 12-1/4 inch back height, fabricated from steel sheets not less than 18 USS gauge, independently secured to building walls with suitable brackets. Provide necessary corner fittings and end covers. Install air vents on hot water radiators at all points where piping drops through the floor. Provide enclosures of zinc-coated, bonderized steel with a baked enamel finish of color selected by the Engineer. Provide access to all vents through hinged access doors. Equip steam radiation with valves and traps as indicated.

2.7 CONVECTORS

- A.** Extended surface-finned tubes type consisting of square aluminum fins bonded to a copper tubing core. Provide convectors of dimensions and capacities not less than those indicated, determined in accordance with I-B-R Code, have a removable slotted front and be freestanding. Design convectors to be semi-recessed in walls. Equip the supply pipe to each hot water convector with a radiator valve, packless hot water type. Equip the return pipe from each connector with a balancing valve. Provide enclosure having a baked enamel finish of color selected by the Engineer. Equip steam connections with valves and traps as indicated.

2.8 AUTOMATIC AIR VENTS

- A.** Equip hot water heating systems with automatic air vents at all high points in mains, where indicated or required for the proper operation of the heating system, with pet cock on inlet tapping.

2.9 HOT WATER THERMOMETERS

- A.** Provide hot water thermometers of the separable type with 7-inch scales for the water lines in the boiler room supply and return from each circuit. Provide thermometers of straight or angle type as necessary, with a range of 30°F to 240°F. Adjustable angle type thermometers may be provided.

2.10 COMPRESSION TANKS

- A.** Provide compression tanks for the hot water or chilled water of sizes and capacities as indicated. Each tank shall be an ASME compression tank with tank air charging and drain valve and essential air control boiler and tank fittings on each tank.

2.11 STRAINERS

- A.** 2-1/2 inch and smaller 600 pound socket weld, Y-pattern, fully ported ASTM A 216, Grade WCB: 40 mesh monel screen for steam, 20 for water.
- B.** 3-inch and larger 250 pound flanged, Y-pattern, semi-steel, full ported, screen same as smaller strainers.

2.12 GASKETS

- A.** Use composition gaskets on all services except steam and high temperature water. HTW and steam gaskets: Spiral metal and mineral wool with steel retaining ring 300 psig rating.

2.13 STEAM TRAPS

- A.** Medium pressure traps (30 to 50 psi systems): Inverted bucket type, as indicated.
- B.** Low-pressure steam traps (5 psi-15 psi): Float and thermostatic type, as indicated.
- C.** Provide all traps having cast iron or bronze bodies with stainless steel trim.

2.14 GAUGES, STEAM AND WATER

- A.** Indicated pressure range, 4-1/2 inch size with cast aluminum cases, phosphor bronze, Bourdon tube, monel rotary movement and nylon gears, silver soldered joints, accuracy of 1/2 of 1% of scale range.

2.15 DUPLEX STEAM CONDENSATE RETURN PUMPS

- A.** Packaged duplex unit with turbine type pumps coupled to motor and mounted on integral steel base plate and channels, all steel or cast iron receiver, furnished with strainers and piping between pump and receiver. Provide unit with a mechanical alternator to automatically activate one pump and then the other and also activate the second pump if the flow is too great for one pump. Provide a manual lead/lag switch to select which pump starts first. Assemble the entire unit as a complete factory unit for shipping.

2.16 AIR CONDITIONING UNITS - AIR COOLED (Wall Type)

- A.** Packaged air cooled air conditioning unit of one piece construction, completely assembled, wired, and factor tested, including a full operating charge of Freon 12 or 22, evaporator section with centrifugal fan, permanent filter, cooling coil with refrigerant piping and accessories. Design condenser section with centrifugal fan to draw air through and discharge from the rear of the unit. Provide units having a hermetic compressor, air distributing vanes and a spare set of filters.

2.17 AIR CONDITIONING UNITS - WATER COOLED

- A.** Single package, vertical type including a self-contained water-cooled condenser, air-handler and filter section. Provide disposable type fiberglass filters and replace with new sections upon completion of work.
- B.** Compressor: Hermetic type equipped with vibration isolators, filter-drier and located in a sound attenuating compartment in the unit cabinet. Provide evaporator consisting of aluminum plate fins mechanically bonded to seamless copper tubes and fed by a thermostatic expansion valve.

- C. Fan: Forward-curved centrifugal type, belt driven with an adjustable motor pulley, permanently lubricated type bearings including motor bearings.
- D. Controls: Factory wired and including multi-position switches to control unit for continuous fan operation, cooling operation and temperature control located in a control panel on unit cabinets. Provide protection devices including high and low pressure protection, loss of charge protection and current sensitive overload relays. Provisions for 24-volt, remote thermostat shall be part of unit main control box design. Provide timed delay circuit to protect the compressor against short cycling.
- E. Conform to ASME safety code. Provide units containing a water-cooled, tube in tube condenser, with continuous seamless copper tubing with no interior joints. Provide units containing a full operating refrigerant charge. Equip condenser with a refrigerant pressure water-regulating valve.
- F. Provide the unit with a prime coat suitable for painting. The casing shall be factory insulated with one-inch, neoprene coated fiberglass material.

2.18 AIR CONDITIONING UNITS - REMOTE AIR COOLED

- A. Provide combinations split indoor air handling units and remote air-cooled condensing units matched to be a balanced operating package.
- B. Provide systems having capacities as indicated, using refrigerant 22.
- C. Air Cooled Condensing Units: Seamless copper tubes with aluminum fins mechanically bonded. Coil circuited for sub cooling.
- D. Provide units with direct-driven, propeller-type fans and motors of the permanently lubricated type, resiliently mounted. Furnish each fan with a safety guard. Include controls for cycling fan(s) for intermediate season operation.
- E. Compressors: Welded-hermetic type with internal vibration isolation or serviceable hermetic design with external spring isolators and including an automatically reversible oil pump depending on unit sizes.
- F. Controls: Factory wired and located in a separate enclosure. Include in the unit wiring a positive acting timer to prevent short cycling of compressor. Provide other protective devices including crank case heater, high and low pressure safety switches, suction line accumulator, filter-drier and liquid line sight glass. Use the filter drier during test start-up and operation and replace with a new unit upon acceptance. Provide accessories including necessary transformers, thermostats, head pressure control and relays.

- G.** Casing of Condensing Unit: Fully weatherproof for outdoor installation, casing of galvanized or zinc grip steel, zinc phosphatized and finished with baked enamel.
- H.** Indoor Units: Direct expansion fan coil units, with capacities as indicated, basic unit enclosing coil, fan, fan motor with adjustable belt drive, condensate pan and drain, filter frame and thermowave type fiberglass filters.
- I.** Casing: Welded angular frames supporting the major components as well as the panels, casing zinc-coated, or galvanized steel, bonderized, finished with a prime coat suitable for painting. Factory insulate casing with one-inch neoprene coated fiberglass material.
- J.** Cooling Coils: Nonferrous construction with mechanically bonded plate fins.
- K.** Evaporator Fan Section: Forward curved double inlet fans, statically and dynamically balanced and permanently lubricated bearings. Provide fan motor having permanently lubricated bearings.

2.19 AIR CONDITIONING AND HEATING - PACKAGED

- A.** Cooling Unit: One-piece, factory-assembled, tested, precharged, prewired and ready-to-operate unit, designed for roof mounting including a package rooftop adapter matching the basic machine. Provide unit including a gas indirect-fired heat exchanger furnace.
- B.** Total Cooling and Heating Capacity: Not less than indicated.
- C.** Provide unit containing an indoor filter and fan section, compressor section and necessary electrical controls, enclosed in a single weatherproof casing.
- D.** Include a welded or bolted hermetic compressor with suitable vibration isolators, crankcase heaters and automatically reversible oil pump. Include in the refrigerant piping filter-dryer, solenoid valve, expansion valve and sight glass.
- E.** Coils: Nonferrous construction with aluminum plate fins mechanically bonded to seamless copper tubing, with all joints brazed.
- F.** Indoor Fan: Centrifugal forward-curved blower, belt-driven by a permanently lubricated motor of appropriate size mounted on vibration elimination base, fan shaft bearings permanently lubricated type and fan rated as indicated with an external static pressure established by the manufacturer to suit the accessory package specified hereinafter.
- G.** Outdoor Fan: Propeller type, direct-driven by a heavy duty, permanently lubricated motor with a safety guard. Provide unit such that it shall be unnecessary to run the condenser fan to obtain ventilation.

- H.** Cabinet: Constructed of galvanized 18 and 16 gauge steel, bonderized and finished with baked enamel top, bottom and sides of the cooling and heating exchanger sections fully insulated to prevent sweating and to muffle sounds. Include provisions for draining base pan through a drain connection. Provide an opening for power connections and panels easily removable to provide access for servicing. Provide a filter section with replaceable 2-inch fiberglass files easily removed and replaced. Install new filters to replace existing filters upon acceptance.
- I.** Provide electrical control assembly containing a low voltage control circuit transformer, compressor relay, fan relay and a compressor motor timing circuit to prohibit restarting of compressor motor more than once every five minutes. Provide compressor protection devices of the automatically reset type. In addition, include a "free cooling" adapter and room thermostat equipped with an "on-off" switch for manual seasonal use. Equip compressor to prevent operation when outside air is below 40°F. Provide head pressure control.
- J.** Provided a factory built and wired accessory adapter with self-contained positioning motor and damper to continuously proportion amount of outdoor air to return air up to a normal requirement, a roof curb, a fiberglass duct package and a combination supply and return duct-mounted air diffuser, together with concentric duct package, as part of the package.
- K.** Heat Exchanger Section: 18 gauge aluminized steel certified by the American Gas Association specifically for outdoor application; burners of 20 gauge aluminized steel; the gas fired unit equipped with automatic spark ignition and forced combustion blower. Provide unit equipped with a two-stage gas valve.
- L.** Provide central control panel, with lights indicating power on, pilot outage, clogged filter, safety control reset, fan-on-auto and heat-off switches.

2.20 AIR CONDITIONING UNITS - SELF-CONTAINED

- A.** Provide self-contained air conditioning unit containing heating and cooling package rated to meet the capacity conditions indicated, consisting of wall box, room cabinet, hot water heating coil section or steam coil, fan section, and package cooling section with outdoor air damper.
- B.** Exterior Louver: Extruded anodized aluminum, color as selected by the Engineer.
- C.** Heating and Fan Section: Contain the hot water heating coil or steam coil, room air fans, control box, main electrical connection to the unit junction box and polarized disconnect for the cooling section power supply, extra relay with one normally open contact for controlling the hot water circular with coil voltage as indicated, connected across the motorized valve. Do not equip the steam coil units with extra relay. The entire heating section shall have internal thermal insulation.

1. Hot Water Coil: One row serpentine with 3/8-inch O.D. seamless copper tubes mechanically expanded to aluminum fins; each coil having opposite end connections, supply connection on the right side with return connection on the left side, facing the unit. Provide a factory prewired, unmounted, motorized control valve for installation at the site.
 2. Steam Coil: Steam distributors' type for nonfreeze protection with factory supplied steam valve.
 3. Room Air Fans: Aluminum forward-curved centrifugal type of sufficient size to assure quiet operation. Fans direct driven from the permanent split capacitor room air fan motor with double extended shaft, fan shaft having a rust inhibiting coating, fan motor having built-in thermal overload of the automatic reset type, and the motor resiliently mounted, designed for single phase operation, voltage as indicated.
- D.** Control Package: Consist of control components to provide unit-mounted, automatic changeover control for each pair of self-contained units on a single thermostat with master-slave system, as indicated. Include a polarized male disconnect plug for connection to unit junction box on wall sleeve. Each unit shall provide 20% fresh air with a motorized damper control. On a call for heat, the motorized valve shall open and the circulator shall start. When satisfied, the reverse cycle shall stop the circulator.
- E.** The control package shall control a motorized valve on a steam coil as described above without circulator control.
- F.** Cooling Section: Complete assembly including hermetically sealed, split capacitor, motor-compressor unit with overload protection, condenser unit, condenser coil, condenser fans and motor, evaporator coil, condensate removal system, fresh air damper assembly and air filter. Include in the assembly all refrigeration circuit tubing, wiring and safety controls, suitable for operation down to 35°F outdoor ambient.
1. Motor-Compressor Unit: Vibration isolated internally and externally and connected in such manner as to prevent transmission of vibration to other components within the section.
 2. Condenser Coil: Constructed of seamless copper tubes, mechanically expanded into aluminum fins. Provide easily removable condenser cover panel to permit cleaning of the entering air side of the condenser coil.
 3. Condenser Fans: Forward-curved aluminum, sized as required, condenser fan motor of permanent split capacitor type with built-in automatic reset thermal overload protection, motor shall drive the fan directly with a double extended shaft, coated with a corrosion-resistant compound. Provide fan motor having permanently lubricated sealed bearings.

4. Evaporator Coil: Similar to the condenser coil, positioned above an insulated drain pan, condensate directed into the condenser fan scrolls for re-evaporation on the condenser coil.
 5. Apply a continuous film of thermal setting plastic to all metal parts exposed to exterior atmosphere. Insulate the cooling section bottom pan to prevent sweating. Provide stainless steel sheet metal fasteners when subject to corrosive atmosphere.
 6. Ensure the condenser motor and compressor capacitor are readily accessible. Protect electrical terminals with rubber cover seals. System voltage shall be as indicated.
 7. Cooling Section: PVC air seals, thermally and sound insulated, and having a polarized disconnect plug. Provide cooling section containing the ventilation air damper, damper seal, electric damper motor and damper linkage assembly.
 8. Provide a permanent type filter, easily removed and replaced.
- G.** Cabinet Assembly: Decorator type with round edge bar stock steel and discharge grilles having chamfered ends; cabinet top and front 16 gauge with 18 gauge access and end panels, phosphatized and finished in medium gray semi-gloss baked enamel suitable for final finish or for repainting.
1. Provide intake collar of anodized aluminum identical in appearance to the intake louver.
 2. Provide standard controls consisting of "Off-On", "Fresh Air", and fan "High-Low" speed push buttons.
- H.** Provide unit such that it shall be unnecessary to run the condenser fans to obtain ventilation.
- I.** Provide one unit in each room which shall serve as the master unit controlled directly by a unit-mounted, heating-cooling thermostat and the second unit shall be a slave unit controlled through extra relay contacts in the master unit.

2.21 FAN-COIL UNITS - WATER HEAT

- A.** Fan Coil Unit: Vertical freestanding type with 18 gauge or better decorative panels, acoustically and thermally insulated, cabinet surfaces having no sharp edges and finished in baked enamel in color to be selected by the Engineer.
- B.** Interior Surfaces: Constructed of anti-corrosive materials, preferably zinc-coated sheet steel.
- C.** Coils: ARI rated, high performance, cooling-heating coils having copper tubes and aluminum fins bonded to the tubes, sweat fitting for supply and return connections. Equip each return connection with an automatic air vent.

- D.** Provide each unit equipped with a combination drain pan and fan board assembly, with the galvanized drain pan insulated on the underside and drain connection piped to the doors or to the drain system as indicated.
- E.** Unit Fan: Centrifugal type, lightweight corrosion-resistant, quiet and efficient, statically and dynamically balanced.
- F.** Motors For Fan Coil Unit: Two-speed type with built-in overload protection. Provide bearings of the bronze sleeve type with readily accessible oil reservoirs.
- G.** Equip each fan coil unit with throwaway type filters so arranged that they may be removed without unlocking the front panel.
- H.** Provide fan coil unit equipped with integral adjustable aluminum blade double deflection grilles.
- I.** Equip fan coil unit handling outside air with a 25% outside air damper assembly so arranged that it will close tight when the fan is shut off.
- J.** Equip units handling outside air with a factory-built wall intake box having a double grille and insect screen. Provide finish of baked-on enamel blending with the building exterior color scheme.
- K.** Provide fan coil units complete with an integral self-contained valve-thermostat combination, modulating water to the coil to automatically maintain preset conditions by sensing recirculated air temperature.
- L.** Include automatic seasonal changeover requiring no external services or devices.
- M.** Provide three-way two position electric motorized valves in each fan-coil unit.
- N.** Provide fan control from a manual selector switch on each unit providing high, low, off-speed selection. In addition, provide a "Cooler-Warmer" adjustment of thermostat setting on each unit.
- O.** Size fan coil units as stipulated by air handling requirements and capacity indicated, each having a standard coil and control package, with controls factory wired and designed for electrical characteristics indicated.

2.22 FAN-COIL UNITS - ELECTRIC HEAT

- A.** Provide units which utilize electric heating coils for total heating, with electric coils interlocked with the fan motor switch. Electric heat shall be possible only when the fan is in operation. Design such that a minimum number of elements are energized on low or medium fan speeds and additional elements as required will be energized upon demand at high-

speed operation. Provide the necessary magnetic contactors and high temperature interlocks with the factory wired units.

2.30 FAN-COIL UNITS - STEAM HEAT

- A.** Provide units which utilize auxiliary steam coils for total heating; coils of single serpentine type to be used with open-close steam supply control valve; entering steam pressure less than 2 psig, entering air above 32°F and the coils installed with the tubes level, not pitched. Provide necessary steam control valve, controls and interlocks for freeze protection with the factory wired units. Provide coils consisting of seamless copper tubes bonded to configured aluminum fins.
- B.** Size fan coil units as stipulated by air handling requirements and capacity indicated, each having a standard coil and control package.
- C.** Provide controls factory wired and designed for electrical characteristics indicated.

2.30 CHILLER

- A.** Chiller Unit: Rated capacity not less than indicated; complete assembly with compressor, condenser, insulated chiller and part winding across-the-line starter, including dual pressure switch, differential oil pressure switch, expansion valve, solenoid refrigerant valve, safety thermostats, temperature controller, pressure relief valve, charging valve, sight glass, chilled water flow switch, liquid line strainer, and a control panel for voltage indicated, wired and shipped complete from the factory.
- B.** Provide condenser either water-cooled or air-cooled in accordance with the following:
 - 1. Water Cooled Condenser: Shell and tube type, built in accordance with ASME code for unfired vessels and provided with safety relief valve. Provide ASME U-1 inspection and National Board registration.
 - 2. Air Cooled Condenser: Matched capacity to the water chiller with the entire system evacuated, dehydrated, tested for leaks and charged to operate with R-22 refrigerant.
 - a. Roof-Top Air Cooled Condenser: Conform to the U.L. Specifications for outdoor operation with casing of 14 and 16-gauge galvanized steel, phosphatized and finished with two coats of alkyd enamel. Provide main unit support frame minimum of 12-gauge galvanized steel.
 - b. Axial Flow Fan: Belt driven up-blast type with permanently lubricated pillow block ball bearings.
 - c. Condensing Coil: Mechanically bonded aluminum fins to seamless copper tubes, factory tested at 425 psi under water and equipped with a subcooling circuit.

- d. Provide condenser starter electrically interlocked with chiller starter with condenser equipped with a fan operating at the conditions as indicated.
 - e. Provide interlocking wiring between chiller and air-cooled condenser.
 - f. Include in the control system a thermostatically operated damper, which shall be installed on the condenser discharge and shall act to limit the head pressure to the minimum necessary to satisfy the air conditioning chiller load down to 40°F outside ambient.
- C. Provide unit including an automatic capacity control system operated electrically and controlled by the return chilled water temperature to provide step unloading of the compressor and reduced motor input at partial loads.
 - 1. Provide controls factory assembled in the control panel.
 - 2. Include in the automatic control system a factory wired and installed control transformer as necessary, safety thermostat, noncycling relay for pump-down, terminal strip, temperature controller, and on-off hand switch, and thermostatically operated valve installed on the condenser water discharge which shall act to limit the amount of condenser water to the minimum necessary to satisfy the air conditioning chiller load.
 - 3. Provide chilled water flow switch interlocked to prevent chiller operation unless flow occurs.
- D. Compressor: Accessible hermetic reciprocating type with 1750 rpm motor for electrical characteristics, as indicated, start unloaded and have at least 3 stages of capacity modulation, and have forced feed lubrication utilizing a positive feed reversible oil pump.

2.30 AIR HANDLING UNITS - HEATING AND VENTILATION

- A. Air handling Unit: Consist of a fan, coil section, an external and by-pass section and a filter section, air unit of steel draw-through type, properly reinforced, coils removable from the top or side, as indicated, duct collars provided on the entering and leaving ends of the unit, with removable panels provided to allow access to all internal parts.
- B. Fans: Double width, double inlet, multibladed, centrifugal type, dynamically balanced, fan bearings permanently sealed and pre-lubricated ball bearing types. Provide the fan section internally insulated at the factory with one-inch fiberglass type insulation securely fastened to the panels.
- C. Coils: Continuous fin and tube type with aluminum fins bonded to copper or red brass tubes; headers of cast brass, heavy copper, or gray close-grained cast-iron accurately machined and hydrostatically tested to 400 psi pressure. Provide coils of equal distributing water types, pitched in the

casing for proper drainage. Provide coils air tested at 250 psig under water.

- D.** Provide external face and by-pass dampers, furnished by the unit manufacturer, mounted as a single unit, attached to the unit casing, proportioned as required. Provide dampers of the opposed blade type locked to splined steel rods which rotate on rustproof nylon bearings.
- E.** Provide filter section of the type indicated with 2-inch throwaway type filters. Provide access doors on each side for removal and replacement of filter elements.
- F.** Equip the entire unit with vibration isolators of the door or ceiling type sized to suit the equipment and absorb the machine vibration.
- G.** Provide motor mounted on a hinged base to allow for adjustment of belt tension. (Motor starter and disconnect furnished and installed under Section 16920 - MOTOR CONTROL CENTERS AND MOTOR STARTERS.) Motor voltage shall be as indicated.
- H.** Mount outside air dampers as a single unit, attached to the unit casing, proportioned as required. Provide dampers of the opposed blade type locked to splined steel rods which rotate to nylon bearings.

2.30 AIR HANDLING UNIT CONTROLS - HEATING AND VENTILATION

- A.** The air-handling unit shall be manually started and stopped as indicated. The electrical starting and stopping devices are not a part of this Section.
- B.** Control System: Utilize a solid state electronic proportioning hot water control panel (without the use of tubes) with provisions for manual overriding, ratio and set point adjustments. Furnish cable as required for duct sensing elements. Build control transformers into units as required.
- C.** Provide control transformers with 120-volt primary and secondary voltage as required for the modulating valve. Furnish bulb thermostats for valve and damper and circulator control.
- D.** Provide control for the coil with an electrically operated valve, three-way modulating type design to mix supply and return hot water in response to indoor-outdoor control as indicated.
- E.** The air handler control system shall function as follows:
 - 1. An outside bulb control shall start the circulator whenever the outside temperature is 65°F or lower. At temperatures higher than 65°F the circulator shall be shut off.
 - 2. The air handler fan shall be started manually. When the fan is started, the motorized, spring return, outside air damper shall open.

- When the fan is stopped, the outside air damper shall close. The manual push button shall be located in the Motor Control Center.
3. A face and bypass damper shall act in response to a control in the delivered air stream to maintain air at a minimum of 70°F with a range permitting up to 80°F when the face damper is closed, the control valve shall go to the full bypass position, recirculating flow to the coil. A freeze protection thermostat shall stop the fan if the leaving coil temperature drops below its setting.
 4. A three-way modulating motorized valve shall act to deliver varying temperature hot water flow to the coil when the outside air is 65°F or below.
 5. The roof ventilators shall be interlocked with the air handler fan circuit, as indicated.
 6. A complete detailed wiring diagram showing all interconnected components with a brief explanation of the control sequence shall be submitted with the Shop Drawings for approval.

2.30 AIR HANDLING UNITS - COOLING, HEATING AND VENTILATION

- A.** Air Handling Unit: Consist of a fan, heating coil, cooling coil section with necessary insulated drain pan, and filter section; draw-through type unit, constructed of steel, properly reinforced with coils removable from the side. Provide duct collars on the entering and leaving ends of the unit. Provide removable panels to allow access to all internal parts.
- B.** B. Fans: Double width, double inlet, multibladed, centrifugal type, statically and dynamically balanced, bearings of permanently sealed and pre-lubricated ball bearing types. Provide air-handling unit internally insulated at the factory with one-inch fiberglass type insulation securely fastened to the panels.
- C.** Coils: Continuous fin and tube type with aluminum fins bonded to copper or red brass tubes. Headers shall be of gray close-grained cast-iron accurately machined and hydrostatically tested to 400-psi pressure. Provide coils tested at 250-psig air pressure under water.
- D.** Units and accessories shall be finished at the factory with the manufacturer's standard process.
- E.** Equip the entire unit with vibration isolators of the floor or ceiling type sized to suit the equipment and absorb the machine vibration.
- F.** Provide motor mounted on a hinged base to allow for adjustment of belt tension. (Motor starter and disconnecter shall be furnished and installed under Section 16920 - MOTOR CONTROL CENTERS AND MOTOR STARTERS) Power to the motor shall be as indicated.
- G.** Heating Coil: Aluminum fins bonded to copper tube, pitched in the unit casing for proper drainage, single tube type furnished with metering orifices in the supply header to insure equal distribution of hot water to

each tube. Provide coils tested at 250-psig air pressure under water. Provide headers of close grained cast-iron accurately machined and hydrostatically tested to 400 psi.

- H. Provide filter section to hold 2-inch throwaway type filters. Flange both inlet and outlet side of section with necessary fastener holes. Furnish filter of medium capacity and filter box having large single access door.
- I. Furnish outside air dampers provided by the Unit Manufacturer, dampers mounted as a single unit, attached to the unit casing, proportioned as required, dampers of the opposed blade type blocked to splined steel rods which rotate on nylon bearings.

2.30 AIR HANDLING UNIT CONTROLS - COOLING HEATING AND VENTILATION

- A. The air-handling unit shall be manually started and stopped as indicated. The electrical starting and stopping devices are not a part of this Section.
- B. Provide for the operation of either cooling coil circulator or heating coil circulator controlled by a summer-winter switch. An outside bulb control shall start the heating circulator whenever outside temperature is 65°F or lower, and start the cooling circulator whenever the outside temperature is 70°F or higher.
- C. Heating Coil Water Valve: Three-way thermostatically controlled, motor operated, modulating type, set to maintain the leaving air temperature at a minimum of 60°F with adjustment to 80°F, if desired. Provide non-freeze protection.
- D. Cooling Coil Water Valve: Three-way thermostatically controlled, motor operated, modulating type, set to maintain the leaving air temperature at 55°F.
- E. The electric duct heater shall raise the air temperature from 55°F to 75°F if necessary during cooling operation.
- F. The outside air damper shall open when unit starts and close tightly when unit stops. Outside air damper shall also be interconnected to open when exhaust fans are operated.
- G. Provide roof ventilators interlocked with the air handler fan circuit.

2.30 ELECTRICAL DUCT HEATERS

- A. Duct Heaters: Voltage, size, wattage, steps and accessories as indicated, UL listed for zero clearance, and conforming to the applicable requirements of the NEC.

- B.** Provide heaters made with galvanized steel frame. Provide terminal box with solid hinged cover in order to minimize dust infiltration.
- C.** Provide resistance coil terminals and nuts made of stainless steel and terminal insulators and bracket bushings made of high-grade ceramic and securely positioned. Resistance wire shall be iron free, 80% nickel and 20% chromium. Bracket supports for the resistance wire shall be reinforced with stiffening ribs and gussets, and spaced no more than 4 inches apart. Provide heaters tested dielectrically for 1000V plus twice the rated voltage or 2000V, whichever is higher.
- D.** Electric Heaters: Flanged type, furnished for 480 volt, 3 phase power, 3 phase heaters furnished with balanced three phase steps, and 120 volt control voltage.
- E.** Provide magnetic contactors to open all ungrounded conductors, one contactor required per step. Contactors: UL listed, rated for 100,000 cycles of operation, resistive rating of 30 amps, and be constructed and listed for 600 volts operation.
- F.** Provide built in and prewired automatic circuit breakers of the thermal-magnetic type for overcurrent protection. The operating handle shall protrude through the control box cover. Provide an automatic circuit breaker to protect the entire heater for heaters rated 24 amps or less.
- G.** Provide a control transformer within each heater control box with a VA rating matched to the quantity of devices to which it must supply power. All ungrounded primary taps shall be as indicated and the secondary voltage shall be 120 volt, 1 phase, 60 Hertz.
- H.** Provide heaters supplied with overcurrent protection per NEC, overcurrent protection consisting of one overcurrent device for entire heater.
- I.** Provide a disc type automatic reset thermal cutout, serviceable through terminal box, for primary protection. Heat limiters in power lines shall serve as secondary protection. In addition, provide a disc type manual reset thermal cut. Manual reset thermal shall be in series with automatic reset thermal cutout. All three devices shall be serviceable through the terminal box, without having to remove heater from duct.
- J.** Provide an interlock relay built in and prewired to terminal blocks and field wired in parallel with the fan starting circuit to prevent heater operation when the fan starter is not energized. Fan control circuit voltage shall be 120 volts, 1 phase, 60 Hertz.
- K.** Provide a pilot light installed in the control box cover prewired and labeled to indicate when airflow switch has opened.
- L.** Provide an airflow-sensing switch of the pressure sensing type built in and prewired into the control circuit. The airflow switch shall have a range adjustment 0.05 inch to 8 inches W.C.

- M.** Provide all heaters with a nonfused disconnect switch, interlocked with the control box door such that the switch must be in the off position before the control box can be opened.

2.31 ELECTRIC WALL HEATERS

- A.** Electric Heaters: Factory assembled wall type cabinet units, consisting of a heating element, fan and motor, housing and built-in thermostat, capacity as indicated.
- B.** Provide electric heaters tested and rated in accordance with the Standard Test Codes of the Air Moving and Conditioning Association, Inc. (AMCA) and bearing their seal and the seal of UL.
- C.** Casings: Bonderized and painted with a primer and finished with baked-on-enamel at the factory; all parts heavily braced and stiffened to prevent vibration and hold all working parts rigidly in line, horizontal and vertical vanes arranged to give uniform air distribution without objectionable drafts.
- D.** Fans: Aluminum bladed, direct connected to the fan motor, dynamically balanced.
- E.** Motors: Totally enclosed continuous fan-duty sleeve bearing type with built-in thermal overload protection.
- F.** Electric Heating Element: Metal sheathed fin tube elements each wired to built-in line voltage automatic reset thermal overhear protection.
- G.** Electric Heater operating characteristics shall be as outline in Part 2 "Electric Duct Heaters" Article.

2.32 ELECTRIC BASEBOARD HEATERS

- A.** Electric Baseboard Heaters: Complete with heavy duty cold rolled steel cabinet with factory finish, aluminum finned tube elements, thermal limit switch and internal thermostat. Heaters shall operate on electrical voltage and capacities as indicated.

2.33 CIRCULATORS

- A.** Circulators: Single stage, centrifugal type, electrically driven, pipe-mounted or base mounted as indicated, capacity not less than that indicated, and direct-connected to the motor.
- B.** Pump Shafts: High-grade alloy steel, runners and glands of bronze, housing of cast iron, and provided with a mechanical shaft seal.

- C. Motors: Sufficient power for the service available, and conforming to the applicable requirements of Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK. All motors 1/2 hp and larger shall be 3-phase, and all smaller motors shall be single phase. Magnetic motor starters shall be furnished for all motors in accordance with Section 16920 - MOTOR CONTROL CENTERS AND MOTOR STARTERS. Provide the necessary multiple pole relays to control the individual circuits in a NEMA 1A enclosure.

2.34 GAS FIRED HEATING AND VENTILATING UNITS - INDIRECT FIRED

- A. Blower Section: Forward-curved, double width, double inlet, centrifugal blower, with self-aligning permanently lubricated ball bearings, air silencer to insure quiet and efficient operation, cushion mounted motor and appropriate drive parts for the indicated air delivery and external static pressure. Blower section shall be rust and acid resistant with suitable interior and exterior finish.
- B. Heating Section: One or more AGA certified duct furnaces for natural gas with type 321 stainless steel heat exchangers, aluminized steel draft hoods, aluminized steel burners, rustproof drain pans and drain connections, and hinged access panels.
- C. Provide factory built transition from blower to duct furnace with matching finish.
- D. Control System: Remote control panel system switch, burner switch and signal lights, magnetic starter or relay for blower motor, modulating and by-pass valve, power venters with proving switch, pressure regulator, automatic main gas valve, high limit switch, filter section with throwaway filters, electric ignition with 100 percent pilot shut-off, insulated blower and transition section, manually adjusted mixing dampers and discharge louver where required, vibration isolators, suspension type and necessary transformer thermostat and disconnect switch.
- E. Provide unit completely factory-assembled and factory wired including completely factory-wired remote control panel. Provide wiring between unit and prewired control panel as specified under Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK and 16920 - MOTOR CONTROL CENTERS AND MOTOR STARTERS. Provide the unit having rust and acid resistance interior and exterior finish. The minimum capacity of each unit shall be as indicated. An extra contact shall be provided in each blower motor starter so that the exhaust system can be interconnected with the unit as indicated. All control shall FM/IRI approved.

2.35 GAS FIRED HEATING AND VENTILATING UNITS - DIRECT FIRED

- A.** Blower Section: One or more forward-curved double width, double inlet, centrifugal blowers, with self-aligning, permanently lubricated ball bearings, an efficient air silencer to insure silent operation, a 460-volt, 3 phase, 60 Hertz ball bearing motor and appropriate drive parts for specified air delivery and external static pressure.
- B.** Burner Section: Burner suitable for complete combustion of natural gas without the aid of a pre-mixer and having turn-down ratio of at least 25 to 1. The equipment manufacturer shall select the burner test suited to the cfm, temperature rise and the fuel indicated. Provide burner having stainless steel combustion baffles, non-clogging gas ports, spark-ignited intermittent pilot and flame safeguard proving rod. Profile plates to control proper air velocity across the burner shall be factory installed, adjusted during an actual firing test and locked in place before shipment. Provide a sight glass in burner cabinet.
- C.** Gas Control System: Manual gas cock, gas pressure regulator, motorized safety shut-off valve, modulating gas valve, gas pressure gauge and pilot cock, regular and solenoid valve.
- D.** Electrical Control System: Remote control pre-wired wall panel, motor starter with overload and extra contact for exhaust system, blower proving switch, entering air temperature switch, burner switch, clogged filter switch with indicating light, ignition and flame safeguard, ignition transformer, modulating outlet air temperature controller, high limit control, safety shut-off alarm relay and control panel box, IRI approved.
- E.** Provide the following accessories: Discharge louver where necessary, filter section, insulated blower section, combination starter with fused disconnect and extra contact, high and low pressure switch and vibration isolators.
- F.** Provide unit completely factory assembled and factory wired including completely factory wired remote control panel. Provide wiring between unit and control panel as specified under Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK and 16920 - MOTOR CONTROL CENTERS AND MOTOR STARTERS. Provide unit having rust resistant interior and exterior finish suitable for high humidity areas. The capacities of each unit shall be as indicated.

2.36 THREE-WAY MIXING VALVE

- A.** Provide a three-way, electrically operated, thermostatically controlled mixing valve for installation on the dual temperature piping systems. The mixing valve shall regulate the leaving water temperature to maintain supply temperature to the fan-coil units indicated. The valve shall mix boiler water at 200°F with system returns to satisfy the condition with the indicated capacity at a pressure drop not in excess of 2 psig under the

indicated conditions. Provide mixing valve complete with linkage and motor and any transformer required.

2.37 VENTILATING EQUIPMENT

- A.** Roof Exhaust Fans: Extruded aluminum, weatherproof housing with a centrifugal fan, motor, belt-driven or direct connected, as indicated. Furnish each unit with a matching manufacturer's standard aluminum prefabricated insulated base approximately 8 inches high or as indicated. The base shall contain a set of delicately balanced gravity shutters, or a motorized damper as indicated. A manual disconnect switch shall be built into each unit. Provide motors 1/2 hp and larger, 3-phase; smaller motors, single phase, for voltage indicated, mounted in compartments isolated from the air stream. Where handling explosive gases, provide explosive-proof motor Class I, Division I, and fan of complete non-sparking construction. All motors shall be single speed with permanently sealed ball bearings.
- B.** Centrifugal Exhaust Fans: Aluminum construction centrifugal type fan units, complete with motors, drive equipment and vibration isolation supports, with air capacities not less than indicated. Provide impeller wheels of airfoil type with backward curved blades, heavily and rigidly constructed, accurately balanced both statically and dynamically, and free from objectionable vibration or noise. For fans handling explosive gases provide fans equipped with nonsparking construction. Motors shall have characteristics as specified for roof exhaust fans.
- C.** Centrifugal Supply Fans: Same as centrifugal exhaust fans.
- D.** Centrifugal Wall Exhauster: Backward curved aluminum airfoil type centrifugal fan direct connected to motor, motors with permanently lubricated ball bearings and self-cooled by fresh outside air. Provide unit of all aluminum construction. Provide automatic shutters furnished by the unit manufacturer. Provide fans with air capacities not less than indicated, when operating against static pressure indicated. Motors shall have characteristics specified for roof exhaust fans. Equip fans with vibration isolators.
- E.** Propeller Fans: Direct-connected and enclosed in the ductwork with which it is associated. Furnish each propeller fan with a matching delicately balanced shutter. The propeller fans shall have capacities not less than indicated. When fans are handling explosive gases, provide fans of sparkproof construction and motors having characteristics specified for roof exhaust fans.
- F.** Vane Axial Fans
 - 1. Provide fan including housing, cast fan wheel, either cast diffuser, or diffuser of heavy fabricated construction, fan shaft, bearing, belt guard, motor and mounting frame as factory-assembled unit.

2. Fan Housing: Not less than 14 gauge steel thickness. Wheel: Aluminum with airfoil blades, statically and dynamically balanced, keyed to the fan shaft and free from objectionable vibration and noise. Bearing: Precision, flange-mounted, self-aligning, antifriction type. Diffuser: Cast aluminum with radially projectioned turning vanes of airfoil cross-section. All sheet metal parts shall be chemically cleaned and spray coated with baked enamel primer finish. Apply additional coat of air-dried enamel on all exterior surfaces after final assembly. Provide fans having air capacities not less than indicated. Motors shall have characteristics specified for roof exhaust fans. Equip fans with vibration isolators.
- G. Motor Operated Dampers:** Multilouvered, constructed of extruded aluminum, at least 0.081 inch thick. Dampers shall be reinforced to prevent vibration, shall be close-fitted and designed to offer a minimum resistance to the flow of air. Provide damper motors electrically connected to open the damper when the fan is started, and to close it when the fan motor stops. Provide motors of spring return type, 480-volts, 3-phase, 60 hertz, a.c.
- H. Back-Draft Dampers:** Consisting of a set of delicately balanced louvers that open automatically, constructed of sheet aluminum of 18 gauge thickness, edges of the blades provided with replaceable strips of neoprene to prevent rattling, and blades supported on metal frames.

PART 3 - EXECUTION

3.1 INSTALLATION

- A.** Installation work shall include all receiving, storing, removing from storage, rigging, uncrating, setting, assembling and aligning necessary to prepare each item of equipment and its integral parts for normal continuous operation. Installation includes assembly and erection of equipment, specialties, controls, instruments and all other accessories furnished by the manufacturer with his equipment. Installation includes initial startup of all equipment, and initial operation of the complete heating, ventilating and air conditioning systems as indicated.
- B.** Furnish all necessary loading and hauling equipment, scaffolding, rigging, cranes, hoists, dunnage and such tools and instruments required to assemble, install, align, connect and make ready for operation all equipment, whether furnished by the Contractor or the Authority.
- C.** Install equipment and piping systems in accordance with Section 15050 - BASIC MATERIALS AND METHODS FOR MECHANICAL WORK, the manufacturer's recommendation and as indicated. Install insulation in accordance with Section 15250 - INSULATION. Install Air distribution System in accordance with Section 15800 - AIR DISTRIBUTION.

D. Heating

1. Install the heating system complete and ready for operation, as indicated. Include operating and safety control wiring.
2. Install thermometers in supply and return lines of each hot water circuit, as indicated, and locate to be read easily from below.
3. Install automatic air vents at all high points in hot water mains and elsewhere as needed for the proper operation of the heating system, with pet cocks on inlet tappings.
4. Water service will be provided under another Section to a point within five feet of the boiler. The connection shall be made under this Section, using Type L copper tubing. Install an approved combination relief and reducing valve on the feed-water line to the boiler.
5. Cut pipe accurately to measurements established at the building, and work into place without springing or forcing, properly clearing all windows, doors and other openings. Remove pipe burrs by reaming and install to permit free expansion and contraction without damage to joints or hangers. Pitch up horizontal mains in the direction of flow with a grade of not less than 4 inches in 40 feet. Cap open ends of pipe lines and other equipment or plug during installation to keep dirt or other foreign material out of the system. Install unions at all points shown and otherwise necessary to make an easily dismantled system. Joints between sections of pipe and between pipe and fittings 1-1/2 inches and larger may be fusion-welded.
6. All caulking sleeves shall be AWWA Standard, Class D, cast-iron wall sleeves, length to accommodate wall thickness. All sleeves shall be made watertight and gastight. Install approved floor and ceiling plates wherever pipes pass through finished floors, ceilings, or partitions.
7. Install compression tanks suspended from ceilings with all essential valves and fittings installed and connected.
8. Install steam piping complete with traps, expansion joints, valves and other accessories. All pitch to condensate traps and steam main shall operate dry.

E. Air Conditioning

1. Install air conditioning system complete and ready for operation, as indicated.
2. Mount each package-cooling unit on the roof with the approved rooftop adapter. Drainage of the base pan shall be installed.
3. In addition to the control assembly, install the "Free-Cooling" adapter and room thermostat.

F. Heating and Air Conditioning

1. Install the heating and air conditioning system-complete and ready for operation, as indicated.
2. Install each self-contained air conditioning unit with all connections for heating and cooling sections, fan and outdoor air damper, in

- accordance with manufacturer's instructions. Install the factory pre-wired, motorized control valve as indicated.
3. Install each fan-coil unit with all supply and return connections and an automatic air vent on each return. Connect drain pan to drain outdoors or as indicated.
 4. Install each prefabricated chiller unit in accordance with manufacturer's instructions. Include operating and safety control wiring.
 - a. Water service will be provided under another Section to a point within five feet of the chiller. The connection shall be made under this Section using Type L copper tubing. Install an approved combination relief and reducing valve on the feed water line to the chiller.
 - b. Condenser water service will be provided under another section to a point within five feet of the condenser. The condenser water connections shall be made under this Section using cast-iron screwed pipe.
 5. Install each air-handling unit in accordance with manufacturer's instructions. Motor starter and disconnect will be furnished and installed under another Section, except as indicated.
 6. Install air handling unit controls including control transformers, bulb thermostats for valve control and electrically-operated valve controls on preheat and reheat coils, and damper motors.
 7. Install air handling unit (cooling coils) controls including control transformers, bulb thermostats for valve control, electrically-operated valve controls on heating and cooling coils.
 8. Hot water circulators shall be pipe mounted or base mounted as indicated. Any unit heater thermostat on a given circuit shall start the circulator for that circuit on a call for heat.
 9. The three-way mixing valve on the dual temperature piping system shall be piped with a shutoff valve in each of the three connections.
- G. Gas Fired Units:** Install gas fired air handling units, heating and ventilation units and forced air duct furnace with necessary ductwork and flue vent as indicated. All gas fired units shall have FM/IRI approved control.
- H. Valves**
1. Install valves at the locations indicated, and where required for proper functioning of the system.
 2. Provide gate valves unless otherwise indicated. Install all valves with their stems horizontal, or above.
- I. Refrigeration System**
1. Install the refrigeration system complete with all piping, valves, accessories and insulation.
 2. Mitering of piping to form elbows, notching straight runs to form tees, or any similar construction will not be permitted.

3. Refrigeration piping shall be tested, dehydrated, and charged before insulating. Test the piping using a test pressure of 150% of service pressure. Add refrigeration duty oil and R-22 to the system for 3 days of test before turning over to the Authority.

3.2 TESTS

- A. Upon completion and prior to acceptance of the installation, test all systems as may be required by the Engineer to demonstrate satisfactory functional and operating efficiency. Operating tests shall cover a period of not less than six hours for each system, and all tests shall be conducted at such time as the Engineer may approve. Provide all instruments, facilities and labor required to properly conduct the tests. Electric power required will be furnished by the Authority. Balance air handling systems and provide three copies of the readings to the Engineer.

3.3 AUTHORITY-FURNISHED EQUIPMENT

- A. Contractor shall provide all labor and material to install, support and connect all equipment furnished by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. HVAC systems will be measured as per each complete in place, including all preparation, fixtures, accessories and incidentals.

4.2 PAYMENT

- A. Payment for HVAC systems will be made at the Contract unit price for the quantities as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1559.039	HVAC	LS

END OF SECTION